RESEARCH PAPER

Behavioral intention to perform risk compensation behaviors after receiving HPV vaccination among men who have sex with men in China

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ABSTRACT

Men who have sex with men (MSM) are recommended to take up human papillomavirus (HPV) vaccination. There are concerns that MSM would increase sexual risk behaviors after taking up HPV vaccination, a phenomenon known as risk compensation. This study investigated the prevalence of and factors associated with behavioral intention to reduce the frequency of condom use with men after receiving the HPV vaccination. The study was based on the baseline sample of an ongoing randomized controlled trial promoting HPV vaccination among MSM in Hong Kong. Hong Kong Chinese-speaking MSM who have never vaccinated against HPV were recruited from multiple sources. A total of 624 participants completed the baseline survey during July to December 2017. The prevalence of behavior intention to reduce the frequency of condom use with regular and non-regular male sex partners after receiving HPV vaccination was 6.9% and 4.0%; 8.0% of them intended to reduce condom use with either type of male partners after receiving the HPV vaccination. Adjusting for significant background variables (education level and condomless anal intercourse with men in the last six months), two constructs of the pre-intentional phase of Health Action Process Approach model were significantly associated with the dependent variable in the expected direction. They were (1) positive outcome expectancies of condomless anal intercourse after receiving HPV vaccination (adjusted odds ratios [AOR]: 1.29, 95% confidence interval [CI]: 1.12, 1.48, $p < 0.001$) and (2) perceived self-efficacy of consistent condom use after receiving HPV vaccination (AOR: 0.83, 95% CI: 0.70, 0.92, $p = 0.001$). Risk compensation may not be a major concern when promoting HPV vaccination among MSM. The results should be assuring health-care providers and policymakers.

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Introduction

Human papillomavirus (HPV) causes genital warts and penile/anal cancer among men.¹ Men who have sex with men (MSM) are at high risk of contracting HPV and its related diseases. A meta-analysis reported an extremely high prevalence of genital HPV infection among MSM both internationally (63.9% in HIV-negative MSM and 92.6% in HIV-infected MSM)² and in China (66.3% among MSM in general).³ Such prevalence was much higher than the male general population (e.g., 12.4% in Europe and 16.9% in China).^{4–6} In addition to the high prevalence of genital warts,⁷ MSM's anal cancer risk is 32–52 times higher than the general population.⁸ The HPV-related cancer risk was the highest among HIV-infected MSM, which accounted for 9.9% of the MSM population in China in 2016.⁹ Although there were no data about the prevalence/incidence of HPV-related diseases among MSM in Hong Kong, such prevalence may be much higher than those of the male general population (genital warts prevalence: 0.94% and incidence: 292.2 per 100,000 person-years).¹⁰

The HPV vaccination is highly effective in preventing vaccine-type general warts and cancers among both males and females.^{11,12} MSM may also benefit from HPV vaccination, as evidence showed that people who have already infected with one

or more HPV types can still get protection from other HPV types in the vaccines.¹³ Moreover, HPV vaccination could also prevent developing/recurrence of subsequent HPV-related diseases (e.g., cervical/anal intraepithelial neoplasia) among people having a history of HPV infection.^{14–16} As a result, the US Centers for Disease Control and Prevention recommends MSM age ≤ 26 y to receive the HPV vaccination.¹³ A national program in the UK is offering HPV vaccination to MSM up to and including 45 y of age.¹⁷ In Hong Kong, two types of HPV vaccines (four-valent and nine-valent) are provided to males aged ≥ 9 y by private physicians. The cost to complete the three-dose course ranges from HK\$2,500 to 4,000 (US\$ 321–514).¹⁸ MSM in Hong Kong had demands of HPV vaccination, as 29.2% of them intended to take up such vaccination at market rate, and 79.1% would do so if it is offered for free.^{19,20} A three-arm, parallel-group, non-blinded randomized controlled trial (RCT) promoting HPV vaccination among MSM in Hong Kong started in July 2017. Participants were Hong Kong Chinese-speaking MSM who had never received the HPV vaccination. A total of 624 eligible MSM completed the baseline survey and were then randomized 1:1:1 into three groups: (1) Intervention 1: exposure to online health communication promoting HPV vaccination among MSM, (2)

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Intervention 2: receiving 15-min motivational interviewing over phone on top of intervention 1, and (3) Control group: exposure to online health communication related to mental health that was unrelated to HPV vaccination. Participants were given coded discount coupons (10% discount of the market rate) for taking up the three doses of HPV vaccines at a collaborating private clinic. Preliminary results were encouraging, as 14.9% and 9.1% of the participants received HPV vaccination after exposure to Interventions 1 and 2, respectively.²¹

There are concerns that people may increase the likelihood of sexual risk behaviors after they are vaccinated against HPV.²² The underlying concept of such concerns is known as risk compensation. Risk compensation describes the phenomenon by which people increase their frequency in performing risk behaviors due to lowered risk perception from the adoption of a preventive measure.^{23,24} Risk compensation behaviors may affect the effectiveness of some biomedical HIV/sexually transmitted disease (STD) prevention methods. For example, simulation studies suggested that a 20% reduction (from 40% to 20%) in condom use after receiving voluntary medical male circumcision (VMMC) would offset VMMC's HIV prevention effects among circumcised men.²⁵ A meta-analysis of 20 studies showed that vaccinating children against HPV did not increase their prevalence of condomless sex, non-use of contraception, or STD.²⁶ To our knowledge, only one study investigated changes in sexual behaviors after HPV vaccination among MSM. The results showed that the majority of the vaccinated MSM did not increase anal intercourse or condomless anal intercourse (CAI) after receiving the HPV vaccination.²⁷

The Health Action Process Approach (HAPA) explains a variety of health-related behaviors.^{28–34} The model suggests that behavioral changes involve two phases (pre-intentional and post-intentional). In the pre-intentional phase, risk perception, outcome expectancies (pros and cons of behavioral outcomes), and self-efficacy (confidence in one's capability to perform a behavior) are determinants of behavioral intention. There are numerous studies only focus on the pre-intentional phase of the HAPA^{35–37} using behavioral intention as the dependent variable. Behavioral intention is one of the strongest prospective predictors of actual behavior.³⁸ Furthermore, the constructs of the pre-intentional phase of the HAPA (risk perception, positive and negative outcome expectancies, and self-efficacy) are modifiable through interventions. Previous studies consistently supported that HAPA is applicable in studying vaccination behaviors, as all its constructs predicted subsequent vaccination behaviors.^{39,40} It has also been used to develop interventions promoting uptake of influenza vaccination.⁴⁰ This study applied a pre-intentional phase of HAPA as framework for variable selection.

This study aimed to assess the impact of HPV vaccination on risk compensation intention (i.e., reduce the frequency of condom use with either regular or non-regular male sex partners after receiving HPV vaccination) among Hong Kong MSM participating in the aforementioned RCT promoting HPV vaccination.²¹ Factors associated with risk compensation intention were also investigated, including background characteristics, perceptions based on the pre-intentional phase of HAPA, and behavioral intention to take up HPV vaccination in the next year.

Results

Background characteristics

The majority of the participants were 18–30 y old (59.6%), currently single (81.7%), full-time employed (78.8%), had attended colleges or above (84.8%), and identified themselves as homosexuals (89.1%). About half of them reported a monthly income of HK\$20,000 (US\$ 2,564) or above (50.1%). Regarding service utilization, 55.4% and 48.1% had taken up HIV testing and other HIV/STD-related prevention services in the last six months. In the last six months, 62.7% and 76.9% of the participants had anal intercourse with regular male sex partners (RP, defined as their lovers or steady boyfriends) and non-regular male sex partners (NRP, defined as casual sex partners and male sex workers); 35.3% reported CAI with any men; and 6.6% and 6.3% used sexual potency drugs and illicit drug use before/during anal intercourse (Chemsex), respectively. Among the participants, 4.2% self-reported to be HIV positive, and 19.4% reported a history of other STDs (Table 1).

Behavioral intention to reduce the frequency of condom use with RP and NRP after receiving HPV vaccination (risk compensation intention)

The prevalence of behavior intention to reduce the frequency of condom use with RP or NRP after receiving HPV vaccination was 6.9% and 4.0%. A composite variable was created representing behavioral intention to reduce the frequency of condom use with either RP or NRP after HPV vaccination (8.0%). This composite variable was used as a dependent variable for subsequent logistic regression analysis (Table 2).

Perceptions based on the pre-intentional phase of HAPA and behavioral intention to take up HPV vaccination in the next year

After being briefed about the efficacy of HPV vaccination, 28.4% of them reported a high/very high chance of taking up HPV vaccination at market rate in the next year. Regarding perceptions based on the pre-intentional phase of HAPA, 35.7% and 51.4% perceived their risk of contracting HIV and other STDs to be somewhat/much lower after receiving the HPV vaccination. Less than one-third (25.8% and 32.7%) perceived some positive outcomes of CAI after receiving HPV vaccination; about half of them perceived some negative outcomes if having CAI after receiving HPV vaccination, such as contracting HIV (52.4%) or other STDs (49.2%), and feeling worried (53.4%) or guilty (41.2%). Majority of them (61.7% and 68.6%) were confident in using condom consistently under different situations after receiving the HPV vaccination. The mean scores and standard deviation (SD) of the following scales were: Risk Perception Scale (mean: 4.9, SD: 1.5), Positive Outcome Expectancy Scale (mean: 5.7, SD: 2.4), Negative Outcome Expectancy Scale (mean: 13.8, SD: 4.1), and Perceived Self-efficacy Scale (mean: 7.7, SD: 2.3) (Table 2).

Table 1. Background characteristics of the participants (N = 624).

	N	%
Socio-demographics		
Age group		
18–30	372	59.6
31–40	179	28.7
>40	73	11.7
Current marital status		
Currently single	510	81.7
Cohabited/married with men	111	17.8
Cohabited/married with women	3	0.5
Education level		
Secondary or below	93	14.9
University or above	531	85.1
Current employment status		
Full-time	492	78.8
Part-time/unemployment/retired/students	132	21.2
Personal monthly income (HKD)		
<10,000	101	16.2
10,000–19,999	207	33.2
20,000–39,999	223	35.7
≥40,000	90	14.4
Refuse to disclose	3	0.5
Sexual orientation		
Homosexual	556	89.1
Bisexual	66	10.6
Heterosexual	1	0.2
Refuse to disclose	1	0.2
HIV/STD-related service utilization in the last six months		
HIV testing		
No	278	44.6
Yes	346	55.4
Other HIV/STDs prevention services ¹ in the past six months		
No	324	51.9
Yes	300	48.1
Sexual behaviors in the last six months		
Had had anal intercourse with regular male sex partners (RP)		
No	122	19.6
Yes	502	80.4
Had had anal intercourse with non-regular male sex partners (NRP)		
No	303	48.6
Yes	321	51.4
Condomless anal intercourse (CAI) with either RP or NRP		
No	404	64.7
Yes	220	35.3
Use of sexual potency drugs before/during anal intercourse with men		
No	583	93.4
Yes	41	6.6
Use of illicit drugs before/during anal intercourse with men (Chemsex)		
No	585	93.3
Yes	39	6.3
History of HIV/STD infection		
Self-reported HIV status		
Negative	552	88.5
Positive	26	4.2
Refuse to disclose	12	1.9
Had never tested for HIV antibody	34	5.4
History of other STD infection		
No	503	80.6
Yes	121	19.4

¹Including condom distribution, education on partners, leaflets of HIV/AIDS information, and seminars.

Factors associated with risk compensation intention

As compared to participants with lower education (secondary or below), those who have attained university degree or above were less likely to show risk compensation intention (univariate odds ratios [ORu]: 0.46, 95% confidence interval [CI]: 0.24, 0.91, $p = 0.024$). Participants reported CAI with men in the last six months had a higher likelihood of risk compensation intention (ORu: 2.77, 95% CI: 1.54, 4.99, $p = 0.001$) (Table 3).

Adjusting for these two background variables, two out of four constructs of the pre-intentional phase of HAPA were

Table 2. Perceptions related to pre-intention phase of HAPA (N = 624).

	%	Mean (SD)
Behavioral intention to reduce frequency of condom use with various partners after receiving HPV vaccination		
How high is your chance of reducing frequency of condom use with regular male sex partners (RP) during anal intercourse after receiving HPV vaccination?		
No (Very low/low/moderate)	93.1	
Yes (High/very high)	6.9	
How high is your chance of reducing frequency of condom use with non-regular male sex partners (NRP) during anal intercourse after receiving HPV vaccination?		
No (Very low/low/moderate)	96.0	
Yes (High/very high)	4.0	
Behavioral intention to reduce frequency of condom use with any type of male sex partners (either RP or NRP) after receiving HPV vaccination		
No	92.0	
Yes	8.0	
Risk perception (% somewhat lower/much lower)		
Perceived change in risk of contracting HIV after receiving HPV vaccination	35.7	
Perceived change in risk of contracting other STDs after receiving HPV vaccination	51.4	
<i>Risk Perception Scale</i> ¹		4.9(1.5)
Positive outcome expectancy of CAI with men after receiving HPV vaccination (% agree/strongly agree)		
Will increase intimacy between you and your male sex partner	25.8	
Will increase trust between you and your male sex partner	32.7	
<i>Positive Outcome Expectancy Scale</i> ²		5.7 (2.4)
Negative outcome expectancy of CAI with men after receiving HPV vaccination (%agree/strongly agree)		
You will contract HIV	52.4	
You will contract other STDs	49.2	
You will feel worried	53.4	
You will feel guilty	41.2	
<i>Negative Outcome Expectancy Scale</i> ³		13.8 (4.1)
Perceived self-efficacy of consistent condom use with sex partners after receiving HPV vaccination under different conditions (%somewhat confident/very confident)		
You are confident to use condom consistently even when you are sexually aroused	68.6	
You are confident to use condom consistently even when your sex partner is not willing to use it	61.7	
<i>Perceived Self-efficacy Scale</i> ⁴		7.7 (2.3)
Behavioral intention to take up HPV vaccination		
How high is your chance of taking up three-dose HPV vaccination at market rate within the next year (after being briefed about the efficacy of HPV vaccination)?		
No (Very low/low/moderate)	71.6	
Yes (High/very high)	28.4	

¹ Risk Perception Scale: two items, Cronbach's alpha: 0.702.

² Positive Outcome Expectancy Scale: two items, Cronbach's alpha: 0.791.

³ Negative Outcome Expectancy Scale: four items, Cronbach's alpha: 0.872.

⁴ Self-efficacy Scale: two items, Cronbach's alpha: 0.825.

significantly associated with the dependent variable in the expected direction. They were (1) the Positive Outcome Expectancy Scale (adjusted odds ratios (AOR): 1.29, 95% CI: 1.12, 1.48, $p < 0.001$) and (2) the Perceived Self-efficacy Scale (AOR: 0.83, 95% CI: 0.70, 0.92, $p = 0.001$). Nonsignificant variables included the Risk Perception Scale, the Negative Outcome Expectancy Scale, and behavioral intention to take up HPV vaccination in the next year (Table 4).

Discussion

In this study, behavioral intention to take up HPV vaccination was assessed after being briefed about efficacies of the vaccines and at market price. Such prevalence (28.0%) was

Table 3. Associations between background variables and behavioral intention to reduce condom use with either RP or NRP after receiving the HPV vaccination.

	Row%	ORu (95% CI)	p Values
Socio-demographics			
Age group			
18–30	7.8	1.0	
31–40	7.8	1.00 (0.52, 1.95)	0.992
>40	9.6	1.25 (0.53, 2.98)	0.608
Current marital status			
Currently single	7.8	1.0	
Cohabited/married with men	9.1	1.18 (0.57, 2.43)	0.659
Cohabited/married with women	0.0	N.A.	N.A.
Education level			
Secondary or below	14.0	1.0	
University or above	7.0	0.46 (0.24, 0.91)	0.024
Current employment status			
Full-time	6.9	1.0	
Part-time/unemployment/retired/students	12.1	1.86 (0.99, 3.48)	0.053
Personal monthly income (HKD)			
<10,000	9.9	1.0	
10,000–19,999	8.7	0.87 (0.39, 1.95)	0.730
20,000–39,999	8.1	0.80 (0.36, 1.80)	0.588
≥40,000	3.3	0.31 (0.08, 1.18)	0.086
Refuse to disclose	33.3	4.55 (0.38, 54.75)	0.233
Sexual orientation			
Homosexual	7.8	1.0	
Bisexual	9.1	1.16 (0.48, 2.85)	0.740
Heterosexual	0.0	N.A.	N.A.
Refuse to disclose	0.0	N.A.	N.A.
HIV/STD-related service utilization in the last six months			
HIV testing			
No	8.6	1.0	
Yes	7.5	0.86 (0.48, 1.53)	0.609
Other HIV/STD prevention services ¹ in the past six months			
No	7.7	1.0	
Yes	8.3	1.09 (0.61, 1.94)	0.777
Sexual behaviors in the last six months			
Had had anal intercourse with regular male sex partners (RP)			
No	9.0	1.0	
Yes	7.8	0.85 (0.42, 1.72)	0.649
Had had anal intercourse with non-regular male sex partners (NRP)			
No	6.6	1.0	
Yes	9.3	1.46 (0.81, 2.63)	0.209
Condomless anal intercourse (CAI) with either RP or NRP			
No	6.2	1.0	
Yes	21.6	2.77 (1.54, 4.99)	0.001
Use of illicit drugs before/during anal intercourse with men (Chemsex)			
No	7.7	1.0	
Yes	12.8	1.77 (0.66, 4.13)	0.259
History of HIV/STD infection			
Self-reported HIV status			
Negative	7.8	1.0	
Positive	11.5	1.54 (0.45, 5.35)	0.493
Refuse to disclose	16.7	2.37 (0.50, 11.15)	0.276
Had never tested for HIV antibody	5.9	0.74 (0.17, 3.19)	0.686
History of other STD infection			
No	8.9	1.0	
Yes	4.4	0.44 (0.17, 1.13)	0.088

ORu: univariate odds ratios; CI: confidence interval; N.A.: not applicable.

Row%, ORu, and 95% CI were bold for variables with $p < 0.05$ in univariate logistic regression analysis.**Table 4.** Factors associated with behavioral intention to reduce condom use with either RP or NRP after receiving the HPV vaccination.

	ORu (95% CI)	p Values	AOR (95% CI)	p Values
Perceptions related to condom use based on the pre-intentional phase of HAPA				
Risk Perception Scale	1.13 (0.93, 1.39)	0.222	–	–
Positive Outcome Expectancy Scale	1.34 (1.17, 1.53)	<0.001	1.29 (1.12, 1.48)	<0.001
Negative Outcome Expectancy Scale	0.98 (0.92, 1.05)	0.596	–	–
Perceived Self-efficacy Scale	0.78 (0.69, 0.87)	<0.001	0.83 (0.70, 0.92)	0.001
Behavioral intention to take up HPV vaccination				
How high is your chance of taking up three-dose HPV vaccination at market rate within the next year (after being briefed about the efficacy of HPV vaccination)?				
No (Very low/low)	1.0			
Yes (Moderate/high/very high)	1.33 (0.72, 2.46)	0.358	–	–

ORu: univariate odds ratios; AOR: adjusted odds ratios, odds ratios adjusted for significant background variables listed in Table 3; CI: confidence interval; – : not considered in the models.

ORu, AOR, and 95% CI were bold for variables with $p < 0.05$ in logistic regression analysis.

comparable to previous studies targeting MSM in Hong Kong (29.2%).^{19,20} Risk compensation intention was investigated among all participants in a hypothetical situation of having taken up HPV vaccination, disregarding their initial intention to take up such vaccines. As HPV vaccination is a new initiative for MSM, more of them may intend to take it up after being exposed to related health promotion. Behavioral intention to take up HPV vaccination was not associated with risk compensation intention. The results suggested that HPV vaccination uptake may not lead to a lower frequency of condom use. An alternative explanation was that performing more CAI was not a reason for MSM to take up HPV vaccination. The prevalence of behavioral intention to reduce the frequency of condom use with RP and NRP after receiving HPV vaccination was low (6.9% and 4.0%). Prevalence of risk compensation intention observed in this study was much lower than those associated with some other biomedical HIV prevention methods among MSM, such as VMMC (15.9%)⁴¹ and HIV vaccines (34.6%).⁴² Such difference may be due to different levels of risk appraisal and fear, as HIV is a more widely known and feared disease than HPV-related diseases. Although the behavioral intention is the strongest predictor of actual behavior, a meta-analysis showed that only half of those with a behavioral intention would translate it into action.⁴³ Therefore, actual risk compensation after HPV vaccination may even be lower among MSM in Hong Kong. Such finding was consistent with the previous study suggesting no evidence of actual risk compensation among MSM.²⁷ Risk compensation may not be a serious concern when promoting HPV vaccination among MSM in Hong Kong.

MSM with lower education level reported significantly higher prevalence of risk compensation behavior (14%). It is possible that they have lower knowledge related to HPV vaccines. Special attention should be paid to MSM of higher risk, as 21.6% of those with CAI in the last six months reported risk compensation intention. This finding was consistent with previous studies showing that presenting multiple risk factors was associated with a higher likelihood of risk compensation.⁴⁴ It is possible that these MSM may continue engaging in CAI regardless of vaccination status.

The results showed that 35.7–51.4% perceived HPV vaccination would reduce their risk of contracting HIV and other STDs. In contrast to the findings of previous studies investigating risk compensation behaviors,^{41,44,45} perceived HIV/STD risk reduction after HPV vaccination was not associated with risk compensation intention in this study. Previous studies suggested that most vaccine recipients understood that the HPV vaccines could not provide them 100% protection against STDs and that behaviors to avoid these risks should be continued.⁴⁶

About 30% of the participants perceived some positive outcomes of CAI with men after receiving HPV vaccination, such as it would increase intimacy and trust between sex partners. Such positive outcome expectancies were associated with a higher intention to perform risk compensation behaviors after receiving the HPV vaccination. It is known that some MSM would express intimacy and trust to their male partners via CAI.^{47,48} Future intervention emphasizing these negative outcomes (e.g., contract HIV/STDs, feel worried, or

guilty) may not be a useful strategy in preventing risk compensation after HPV vaccination in this group.

Perceived self-efficacy of consistent condom use after HPV vaccination was relatively high. Higher self-efficacy of consistent condom use was associated with lower risk compensation intention. Enhancing self-efficacy is likely to reduce risk compensation. Previous studies suggested that low self-efficacy in condom use may be due to lack of self-control and high sexual compulsivity.⁴⁹ Perceived self-efficacy could be improved by skill enhancement, rehearsal, and clear goal settings. Since this was a cross-sectional study and could not establish a causal relationship, it is also possible that risk compensation intention would reduce their self-efficacy of consistent condom use after receiving the HPV vaccination.

Although this study had the strengths of being theory based, it had some limitations. First of all, the participants were recruited by non-probabilistic sampling in the absence of sampling frames. The results may not be representative of MSM in Hong Kong. As compared to participants of a large-scale survey ($n = 4,133$) conducted by the Hong Kong Department of Health, our participants were younger, having a lower prevalence of HIV infection and CAI.⁵⁰ Second, the sample was based on the baseline survey of an ongoing RCT promoting HPV vaccination. The trial participants might have a higher motivation to adopt preventive behaviors. Third, we did not collect the information from participants who refused to participate. Fourth, the scales were constructed for this study in the absence of validated scales. We performed exploratory factor analyses and reported satisfactory internal reliability measures. Fourth, the results were self-reported, and thus, reporting bias might exist. The prevalence of behavioral intention for performing risk compensation behaviors may have been underreported although anonymity should have reduced the bias. Last, we only obtained cross-sectional associations and could not establish causal relationships. Our outcome investigated behavioral intention rather than actual behavior; information on behavioral intention might be different from actual behaviors. However, behavioral intention is a strong predictor of actual behaviors.⁵¹

Conclusion

Prevalence of risk compensation intention after receiving HPV vaccination was low among MSM in Hong Kong. Given that only half of those with a behavioral intention would translate into action, the actual risk compensation may even be lower and may not be a serious concern when promoting HPV vaccination in this group. These results should be reassuring to health-care providers and policymakers.

Methods

Study participants

The data presented in this report were based on the baseline sample of an RCT promoting HPV vaccination among MSM in Hong Kong (the trial was registered at ClinicalTrials.gov, number NCT03286907). Questions asked by this study were parts of the baseline survey of the RCT, which was conducted

from July to December 2017. Participants of the RCT were (1) Hong Kong Chinese-speaking men aged 18 y or above, (2) those who self-reported oral or anal intercourse with at least one man in the last six months, (3) those having no intention to leave Hong Kong for more than one month consecutively within the next nine months, (4) those having regular Internet access, and (5) those willing to be followed up by phone. Those who had ever received HPV vaccination were excluded.

Data collection

Participants were recruited from multiple sources, including outreach in gay venues (bars and saunas), online recruitment, and referrals made by the participants. On-site or through telephone/instant messaging applications, trained fieldworkers screened the eligibility of all interested MSM. All participants were briefed that they would be randomly assigned into three different groups after completion of the baseline survey. The fieldworkers also gave/sent participants an information sheet and invited them to join the study. Guarantees were made on anonymity, and the right to quit at any time and refusal to join the study would not affect their rights to utilize any services. The fieldworkers signed a form pledging that the participants had been fully informed about the study. Among 1,235 prospective participants being approached, none of them had already received the HPV vaccination. A total of 724 MSM were screened to be eligible, 127 (17.5%) refused to participate in the study for time and/or other logistical reasons, and 624 (86.2%) completed the baseline survey. Ethics approval was obtained from the Survey and Behavioral Research Ethics Committee of the Chinese University of Hong Kong and the Joint CUHK-NTEC Clinical Research Ethics Committee.

Measures

Background variables

Information collected included socio-demographics, sexual orientation, history of HIV and other STDs, and utilization of HIV-related prevention services in the last six months (i.e., HIV testing and other services such as receiving condom, peer education and HIV-related pamphlets, and attending HIV-related lectures). Participants were also asked whether they had had anal intercourse with RP and NRP, presence of CAI, and use of sexual potency drugs and illicit drugs (Chemsex) before/during anal intercourse in the last six months.

Behavioral intention to reduce the frequency of condom use with RP and NRP after receiving HPV vaccination (risk compensation)

Participants were asked about their chance of reducing condom use with RP and NRP after receiving HPV vaccination (response categories: 1 = very low, 5 = very high). The responses were dichotomized. The behavioral intention was defined as 'high' or 'very high'. Such a definition has been commonly used in previous studies.⁴⁵ A composite variable was created representing behavioral intention to perform risk compensation behaviors with any type of male sex partners

(either RP or NRP). This composite variable was used as the dependent variable in subsequent analyses.

Perceptions based on the pre-intentional phase of HAPA

Four scales were constructed for this study. They were based on the pre-intention phase of HAPA model.

Two items were used to access perceived changes in HIV and STD risk perception after receiving HPV vaccination (1 = much lower, 2 = somewhat lower, 3 = the same, 4 = higher, and 5 = much higher). The Risk Perception Scale was formed by summing up individual item scores (from 1 = much lower to 5 = much higher). A higher score on the scale indicated a perceived larger increase in the risk of HIV/STDs infections after receiving the HPV vaccination.

Positive outcome expectancy of CAI after receiving HPV vaccination was measured by two items, including: (1) 'CAI after receiving HPV vaccination would increase intimacy between you and your sex partner' and (2) 'CAI after receiving HPV vaccination would increase trust between you and your sex partner'. The Positive Outcome Expectancy Scale was formed by summing up individual item scores (from 1 = strongly disagree to 5 = strongly agree). A higher score on the scale indicated the perceived outcome of CAI after receiving HPV vaccination to be more positive.

Four items (from 1 = strongly disagree to 5 = strongly agree) were used to assess negative outcome expectancy of CAI after receiving HPV vaccination (e.g., 'CAI after receiving HPV vaccination would make you feel worry'). The Negative Outcome Expectancy Scale was formed by summing up individual item scores. A higher score indicated the perceived outcome of CAI after receiving HPV vaccination to be more negative.

Two items were used to measure perceived self-efficacy of consistent condom use after receiving the HPV vaccination. They were (1) 'you are confident to use condom consistently even when you are sexually aroused' and (2) 'you are confident to use condom consistently even when your sex partner is not willing to use it'. The Perceived Self-efficacy Scale was formed by summing up individual item scores (from 1 = very unconfident to 5 = very confident). A higher score on the scale indicated perceived higher self-efficacy of consistent condom use after receiving the HPV vaccination.

Cronbach's alpha for these scales ranged from 0.702 to 0.872.

Behavioral intention to take up HPV vaccination

Participants were briefed about the efficacies of taking up three shots of HPV vaccines within six months (88% for prevention of genital warts and 75% for prevention of HPV-induced cancers)¹³ and the market rate (HK\$2,500–4,000 [US \$321–514] for three shots). They were then asked about their chance of taking up HPV vaccination in the next year (response categories: 1 = very low, 5 = very high). The behavioral intention was defined as 'high' to 'very high'.

Statistical analysis

Using the composite variable representing behavioral intention to perform risk compensation behaviors after receiving HPV vaccination as the dependent variable, ORu of the background variables were estimated. Those background variables with $p < 0.05$ in

univariate analysis were adjusted for in the subsequent multiple logistic regression analysis involving other independent variables. AOR and respective 95% CI were derived from such analysis. SPSS version 21.0 was used for data analysis with p values <0.05 considered to be statistically significant.

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

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Contributor

TW and ZW designed the study and wrote the protocol. ZW designed the questionnaire and analytical plan. TW, SQ, and ZW analyzed and interpreted the data and wrote the manuscript. FY conducted a literature search and participated in the manuscript writing. MI supervised the data collection process. ZW and FY revised the manuscript critically and finalized the paper. All authors contributed to and approved the final manuscript.

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